Some Philosophical Aspects of Particle Physics

1.) Introduction — why should philosophers of science study particle physics?

(a) Relevance of studying a "core" branch of Science

(b) Testing ground for theories of how science develops

(c) Grounding for reductionist Programme

(d) The Speculative & the ultimate nature of Physical reality.

2.) Interthery relations — Heuristic strategies

Theories to be considered

① Relativistic quantum field theory ✓

② Feynman-Dyson diagram techniques ✓

③ Renormalization theory ✓

④ Analytic S-matrix theory ✓

⑤ Axiomatic Field theory — Haag's theorem Haag-Kastler C* algebra formulation. ✓

(6) Chew's Bootstrap – analyticity of the second Rind ✓

(7) current algebra ✓

(8) Unitary symmetries SU(3), SU(6) etc ✓

(9) Parton models as explanation of scaling

(a) Bjorken's Partons

(b) Drell, Levy and Yan.

(c) Landshoff & Polkinghorne?

(10) Coloured quarks and charmed quarks ✓
(quark statistics, suppression ~~changeness~~ strangeness-changing neutral currents, ψ- particles)

(11) Dual resonance models

(a) Veneziano ✓

(b) Koba – Nambu – Nielsen. ?

✓(c) string models – Nambu
Nielsen & Oleson

(d) MIT Bag model Kogut & Kibbard.

(12) Gauge fields

(a) Yang - Mills

(b) Sakurai

✓(c) Salam - Weinberg → neutral currents

(Wheeler) Hawking - Penrose → ✓(d) t'Hooft, renormalizability

✓(e) Politzer, Gross - Asymptotic freedom

↓

Bjorken scaling

?

↑

(13) Renormalization Group methods

(a) Gell-Mann, Low

(b) Wilson

(c) ⟶ Gross, Wilczek

(14) Mueller theory of inclusive reactions ✓

(Feynman scaling)

(15) Spontaneous symmetry breaking

Goldstone's theorem and

its evasion (Higgs-Kibble)

(16) Regge theory ✓

~~33~~ Strategies

1) straight forward mathematical development of existing theories:

exs 12 (c), (d) 2(e), 3 ? 14, 15.

2.) Modification of existing theory:

exs ~~4 [illegible]~~,

3.) analogical extension:

exs $SU(2) \to SU(3) \to SU(4)$ —

i.e. 8 → 10 12(a), (2).

4.) Reformulation followed by "stretching"

ex 1, 11(c), 16

5.) Close computation gap.

Ex 2.

6.) Feed back feature of some model or approximation of old theory as an axiom for the new theory

Ex 4, 7,

$T + A \to T_1 \twoheadrightarrow P$

$\hookrightarrow T'(P) \quad \cdots T_1' \dashrightarrow P?$

7.) ~~Axiomatization~~ Attempts to constrain theories

Ex 5, 6.

Symmetries constrain dynamics

or dynamics constrain symmetries.

8.) Making an Ansatz : Consistency problem?

Ex 11(a)?, 9(b)?, 9(c)?

9.) Make a model. by simplifying assumptions or by making approximation

Analogue models.

Ex 9(a), 11(a)

3.) Appraisal of Theories

A Value of predictions (Experiments per theory)

Ed (1) Ω^-

(2) Lamb regeneration

(3) Lamb shift + electron anomalies

(4) antiproton

(5) neutrino

↓ Importance of quantum production

↓ Bayesian models for methodologies & Appraisal

B Heavy from experiment

↳ adhoc mechanisms

4) How Science Progresses

Application of views of

(1) Kuhn. paradigm shift
irrational band wagon
effects.

(2) Popper Refutation of theories

(3) Lakatos tenacity of hard-cores
positive heuristic
Degeneration of a research
programme.

5.) Ultimate Nature of reality

(1.) open ended reductionism

(2.) Chew's bootstrap, nuclear
democracy

(3.) fundamental particles —
parton v. bootstrap

(4.) Unified field theory of Heisenberg.

(5) Action-at-a-distance theories
illusion of Folds? Hoyle-Narlikar etc.

(6) elementary particles, Cosmology.
(a) Wheeler, Misner
(b) Rindler Sachs.

Queries 1.) How does duality assumption for f-vertex conform with Chew's analyticity of 2nd kind ? ✓

2.) What is status of Drell, Levy, Yan Field theory of ~~proton~~ point protons + assumptions to give scaling ✓

3.) ~~Compatibility of unitarization of dual theories with duality~~ ?

4.) Renormalization group
Wilson's ideas on field theory.

5.) Status of Haag's theorem